Exploration and production of hydrocarbons

dr. Felicitász Velledits

Who am I?

- **Name: Dr. Felicitász Velledits**
- **Employment History:**
- 2014-…….Miskolc University: associate professor.
  Teaching activity: Petroleum geology, Applied geology, Sedimentology, Sedimentology of carbonate reservoirs.
- 2008-2014: Freelance consultant: RAG Hungary, Hungarian Horizon Energy Ltd.,
- Carbonate Facies Analysis of limestone reservoirs. Log and facies correlation and interpretation.
- 2006-2007: Freelance consultant: Geomega (Geological Exploration and Environmental Research Ltd. Budapest). Seismic interpretation.
- Sedimentology and Facies Analysis of the Rotliegend: Dutch Sector, North Sea.
- 2002-2005: Research fellow, Békésy postdoctoral scholarship, Department of Geology, Eötvös Loránd University of Sciences (ELTE), Budapest
- 1999-01: Carbonate expert MOL (Hungarian Oil and Gas Co).
- Analysis of Triassic dolomite reservoir Syria.
- Interpretation of different carbonate reservoir rocks Pannonian basin.
- 1995-99: researcher and postgraduate student, Doctoral School ELTE, Budapest
- 1990-95: maternity leave
- **Education:**
- 1999: PhD, Department of Geology, ELTE, Budapest
- Thesis: Rifting process in the Middle-Late Triassic in the Bükk Mts. (NE Hungary)
- 1987-88: Institute für Paläontologie Erlangen (Germany)
- DAAD (German Academic Exchange Service) scholarship
- - mastering the method of microfacies analysis including diagenesis history
- - getting to know many reefs from different ages and from different parts of the world.
- - mastering in determining Triassic fossils
- 1985: M.S. Department of Geology, ELTE, Budapest
- Thesis topic: Facies investigation of the Berva Limestone (Bükk Mts., N-Hungary)
- 1980-85: Degree course in Geology at Eötvös Loránd University, Budapest.

Course Description

- **The goal of the course is**:

to obtain basic knowledge

- of the origin of oil and gas,
- of the accumulation conditions,
- of the techniques to find and exploit hydrocarbons

- **Additional Reading Material**:
  Mike Sherherd (2009): Oil Field Production Geology. AAPG Memoir 91. 1-360.

  Bjorlykke K. (2010): Petroleum Geoscience: From Sedimentary Environments to Rock Physics. Springer.

  Hyne N. J. (2001): Nontechnical Guide to Petroleum Geology, Exploration, drilling, and Production. 1-598. PennWell Corporation.

  Slatt R.M. (2009): Stratigraphic Reservopir Characterization for petroleum Geologists, Geophysicists and Engineers. 1-478. Elsevier.

  Stoneley Robert (1995) Introduction to Petroelum Exploration for Non-Geologsists. 119. Oxford University Press

  Hunt, J.M. (1995) Petroleum Geochemistry and Geology. 2nd edition. 1-743. W.H. Freeman & Co.

  Tissot B.P. & Welte D.H. (1978) Petroleum Formation and Occurrence. 1-538. Springer.

Carbonate Reservoirs:

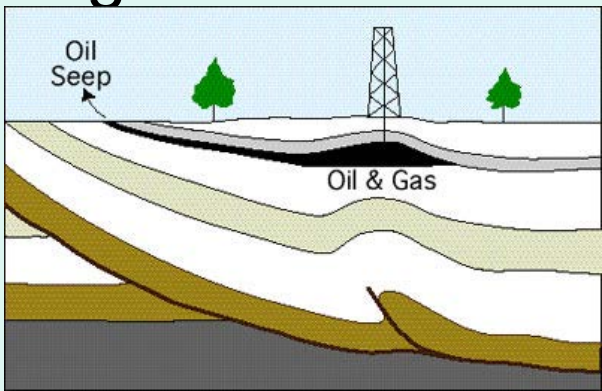
Wayne M. Ahr (2008) Geology of Carbonate Reservoirs. 277. Wiley Publication

Lucia (1999, 2007): Carbonte Reservoir Characterization. 226. Springer.

- **HISTORICAL REVIEW OF PETROLEUM EXPLORATION**

The early uses of oil

- **for medicine.** Oil was applied externally for wounds and rheumatism and internally as a laxative.
- **Waterproofing:** from the time of Noah, pitch has been used to make boats watertight.
- Warfare.
- Up until the mid-nineteenth century, asphalt, oil, and their by-products were produced only from seepages, shallow pits, and hand-dug shafts.



- in 1847 James Young **in Scotland**, produced solid paraffin wax, and liquid paraffin (kerosene or coal oil) from Carboniferous shales. It was the birth of the **oil shale industry**.
- In America G.H.Bissell (New York) was the first to produced kerosene from oil to produce in 1850.
- **Kerosene** was used for lamps. Kerosene became cheaper than whale oil, and therefore the market for liquid hydrocarbons expanded rapidly in the mid-nineteenth century.



The first oil producing well

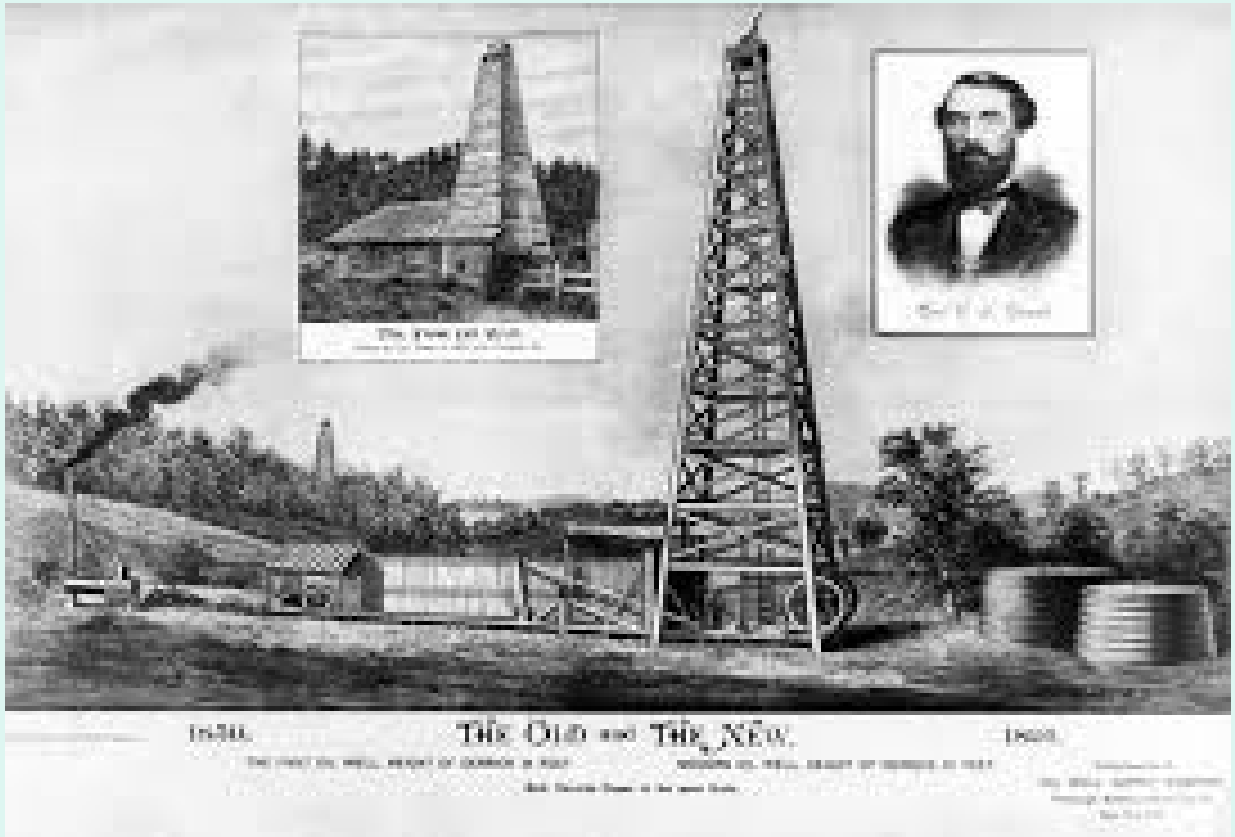


- was drilled at Oil Creek, **Pennsylvania**,

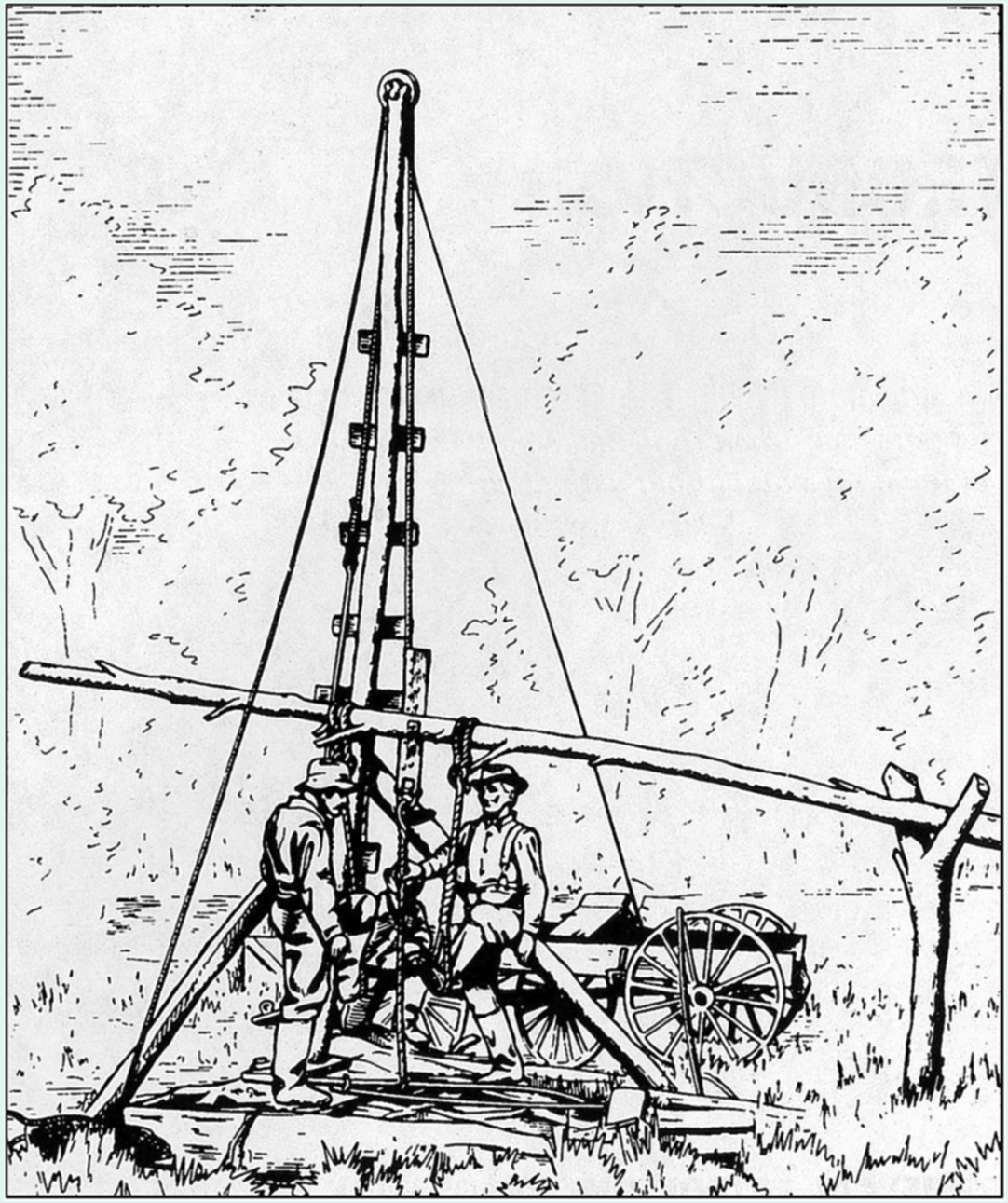
by Colonel Drake in 1859.

Started at the beginning of April and on 29th of August oil came up in the well.

- They drilled 1m/day



Cable-tool drilling was an established technique in many parts of the world looking for water.

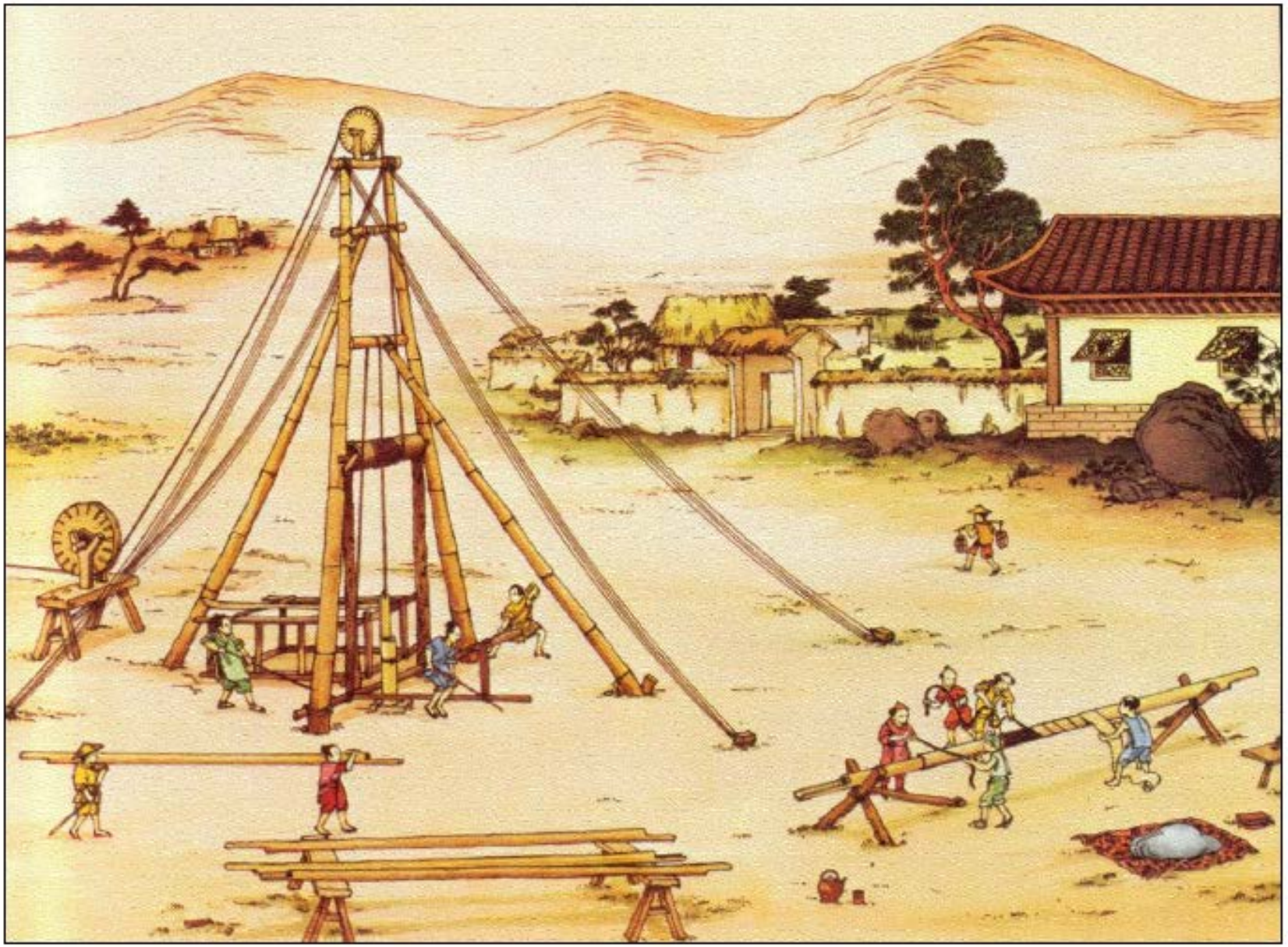



Welcome To
TITUSVILLE
Birthplace of the Oil Industry
1859

Technology for Drake's well

- Was derived from Chinese workers who had travelled to the United States to work on the railroads.
- Cable-tool drilling had been used in China since at least the first century BC. The tower was from bamboo and it was 60 m high. In China, this drilling technology had developed to produce artesian brines, not petroleum.

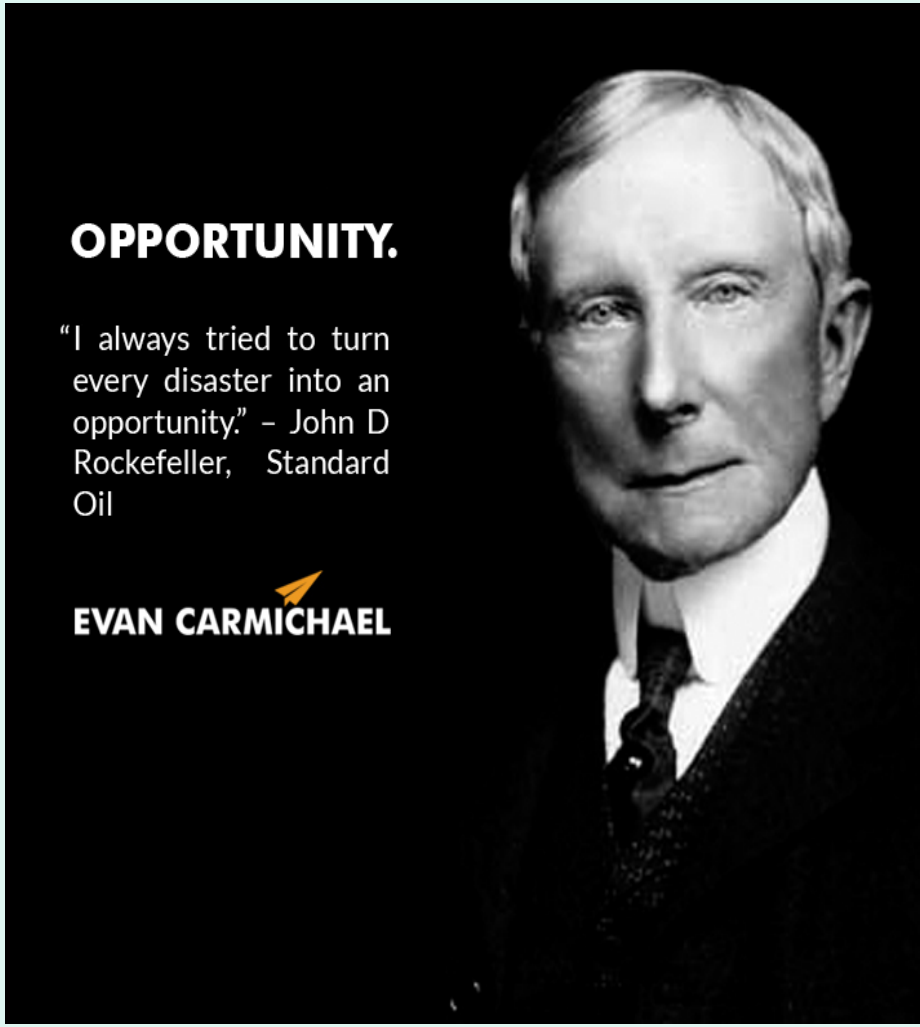
Hydrocarbon History



John D. Rockefeller

- Established oil refinery.
- Instead of drilling for oil, **he concentrated on refining**. Kerosene and gasoline grew in importance.

- Rockefeller became **the richest person** in the country.
- Controlled 90% of the United States oil.
- Oil was used as light source, and fuel in automobile.

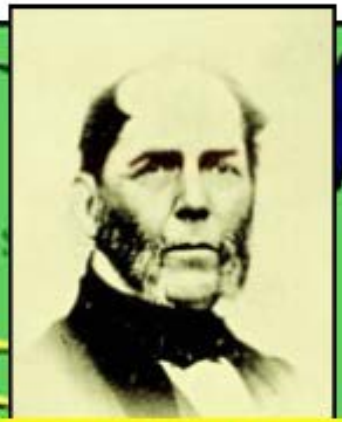


1870s and 1880s

- Major stimulus to oil production was the development of the internal combustion engine in the 1870s and 1880s.
- Henry Ford : the first car, which was driven by petrol.

- **First World War: 1914 -1918**
- Demand for oil products increased greatly.

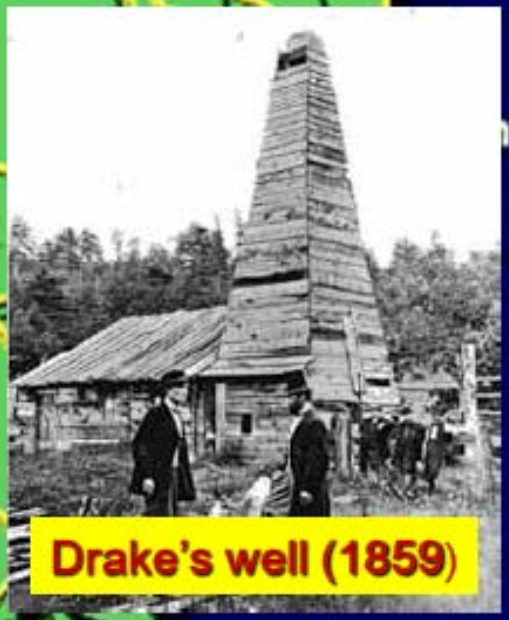
Early History - Appalachians



Dr. Abraham Gesner – 1849
Distills Kerosene
from Oil - Whale Oil Ends



1862 - Clark & Rockefeller
Invest in Refinery



Drake's well (1859)



1830-1860 US Rail Lines
boom



1860 – 1875 Oil Boom

“Seven sisters” (by 1920s)

the oil industry was dominated by seven major companies

- **European:**
- British Petroleum (BP)
- Shell (originally trade company)
- **American:**
- Exxon (formerly Esso)
- Gulf
- Texaco
- Mobil
- Socal (or Chevron)

To export oil from the producing countries as cheap as possible and to sell it in the world market for the highest price possible.

Tonne versus barrel

- **British Petroleum and Shell** found their oil reserves in the Middle and Far East.
  - Long distance transport by sea



  - Used **tonne** as unit of measurement.

  - American companies



  - Short transport distances



  - Used **barrel** as unit of measurement.

- 1 bbl=158,7 l
- 1 m^3=ca. 6,3 bbl
- 1 ton=7,3 bbl
- 1 ml(mile) = 1,6 km
- 1 ml^2=2,56 km^2
- 1 acre=4046.8 m^2

After the Second World War

- **Consortia**, or **joint ventures**

Companies invested in sevaral joint ventures.

TABLE 1.1 Partners of Some of the Major Overseas Oil Consortia[a]

Companies	The Consortium, Iran	I.P.C., Iraq	Aramco, Saudi Arabia	Kuwait Oil Co., Kuwait	Admar, Abu Dhabi	A.D. P.C., Abu Dhabi	Oasis, Libya
B.P.	X	X		X	X	X	
Shell	X	X				X	X
Exxon	X	X	X			X	
Mobil	X	X	X			X	
Gulf	X			X			
Texaco	X		X				
Socal	X		X				
C.F.P.	X					X	
Conoco							X
Amerada							X
Marathon							X

OPEC

- In 1960, the **O**rganization of **P**etroleum **E**xporting **C**ountries (OPEC) was founded in Baghdad.

Consisted initially of **Iraq, Iran, Kuwait, Saudi Arabia, and Venezuela.**

Later joined **Algeria, Dubai, Ecuador, Gabon, Indonesia, Libya, Nigeria, Qatar, and the United Arab Emirates.**

OPEC is an organisation, which struggled again the dominance of the USA, England and Netherland in the oil market.

Prerequisites for OPEC members

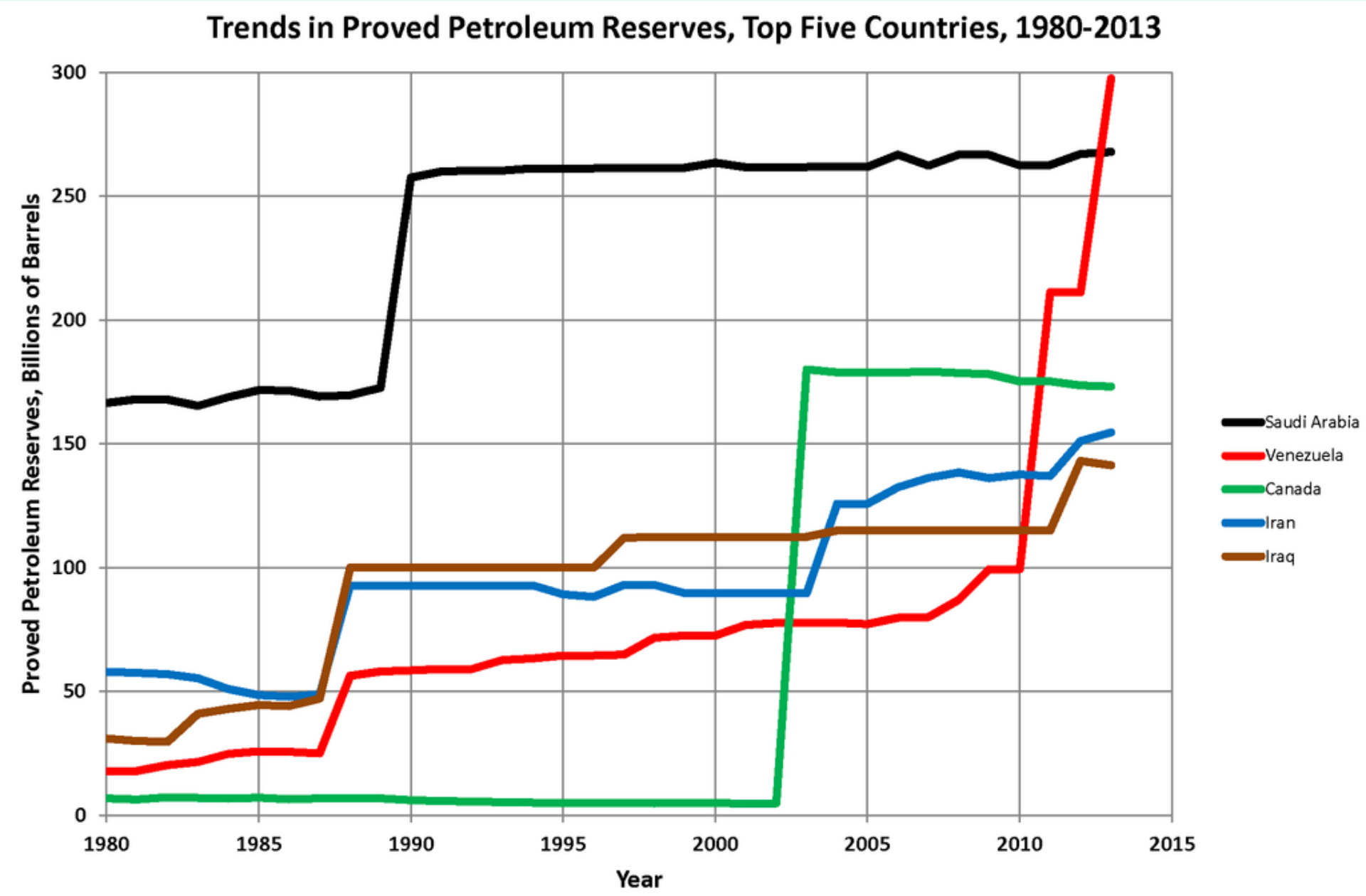
- **OPEC members**: the country's economy must be predominantly based on oil exports. United States and United Kingdom are not members.
- By the mid-1970s, OPEC was producing two-thirds of the free world's oil.
- For many OPEC countries, oil is their only natural resource. Once it is depleted, they will have no assets.

State oil companies: **„New seven sisters”**

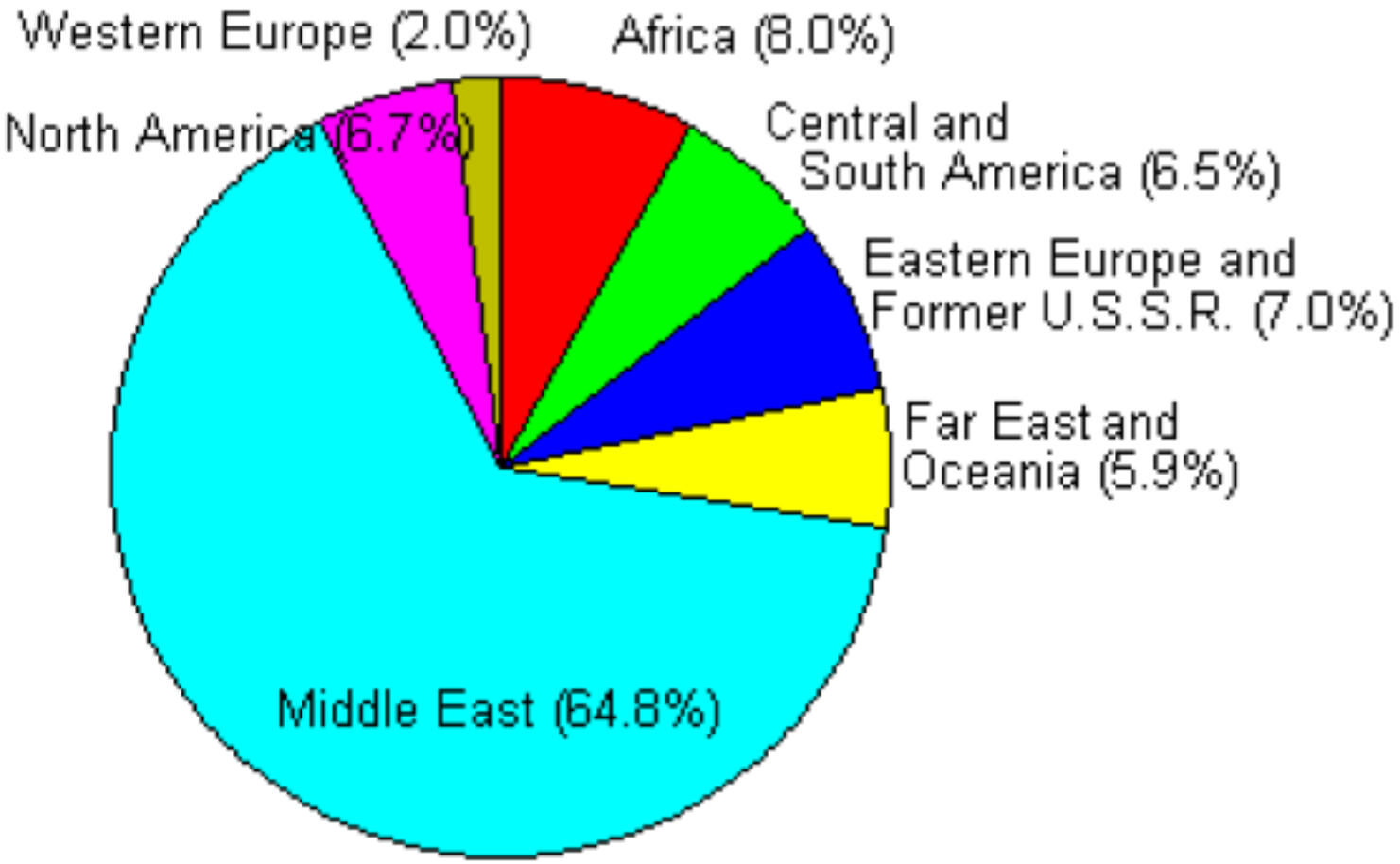
China National Petroleum Corporation (China)
Gazprom (Russia)
National Iranian Oil Company (Iran)
Petrobras (Brazil)
Petroleos de Venezuela S.A. (Venezuela)
Petronas (Malaysia)
Saudia Aramco (Saudi Arabia)

The taxpayer share the risk and the profit.

They are the new rule makers, and **control almost one-third of the world’s oil and gas production** and more than **one-third of the world’s total oil and gas reserves.**


Trends in Proved Petroleum Reserves, Top Five Countries, 1980-2013
Proved Petroleum Reserves, Billions of Barrels
300
250
200
150
100
50
0
1980
1985
1990
1995
2000
2005
2010
2015
Year
Saudi Arabia
Venezuela
Canada
Iran
Iraq

World Oil Reserves, by Region (DOE)



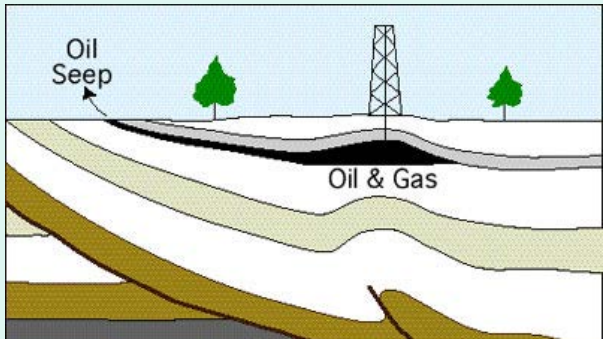
Evolution of Petroleum Exploration Concepts and Techniques

- In the early days:
- to drill on old Indian graves
- to put on an old hat, gallop about the prairie until his hat dropped off, and start drilling where it landed.

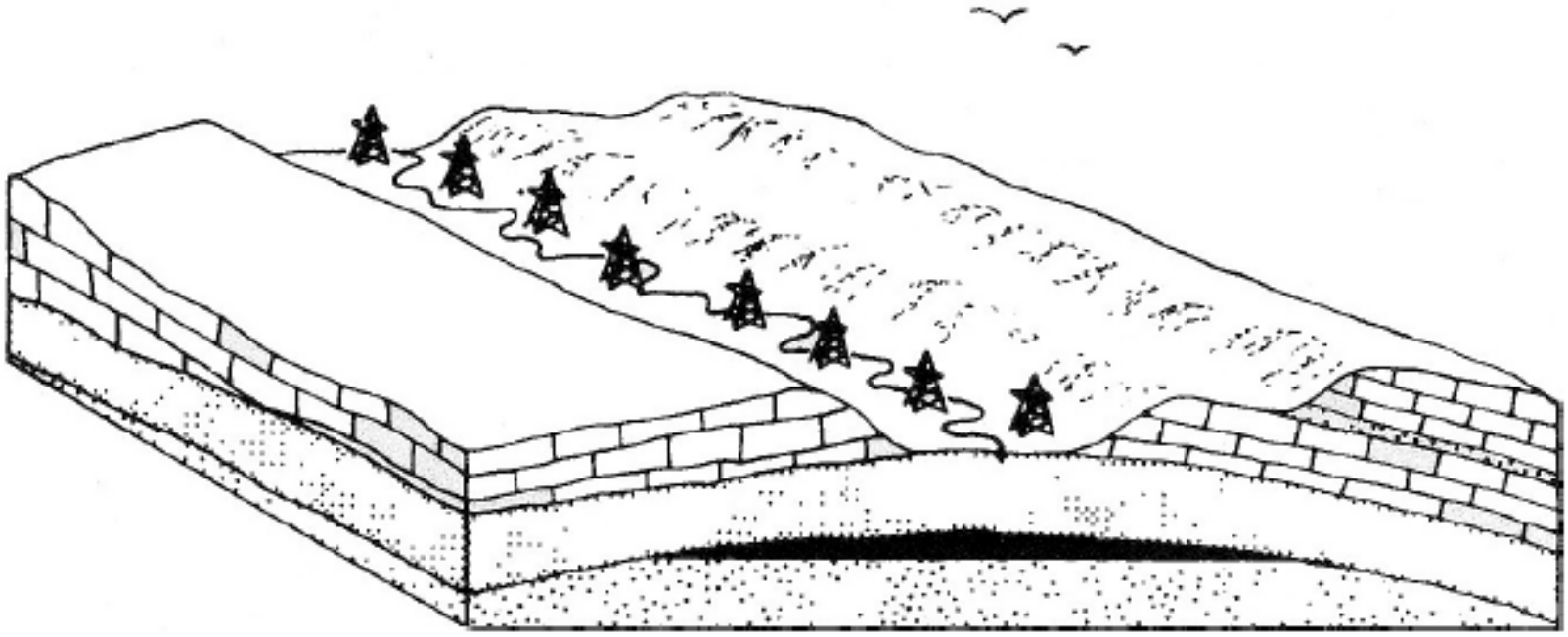
Creekology:

Wells located on river bottom were more productive, than those on the hills.

Hunt 1861: **anticlinal theory** (even today the most successful exploration concept).



Creekology



1.2 Creekology—the ease of finding oil in the old days.

Carll 1880 (stratigraphic trap)

- The oil-bearing marine Venango sands of Pennsylvania **occurred in trends that reflected not structure, but paleoshorelines**. Oil could be trapped stratigraphically as well as structurally. Stratigraphic traps are caused by variations in deposition, erosion, or diagenesis within the reservoir.

End of the nineteenth and the early part of the twentieth century

Exploration was based on the surface mapping of anticlines. Stratigraphic traps were found accidentally.

In the mid-1920s, seismic (refraction), gravity, and magnetic methods were all applied to petroleum exploration.

- 1927: borehole logging, with the first

electric log run in France. Schlumberger.

Micropaleontology: biostratigraphic zones

were define by microfossils.

Late 1950s-early 1960s: modern

sedimentary environments were studied (Missisipi delta, Bahama Bank, Arabian Gulf). Improved prediction of the geometry and internal porosity and permeability of the reservoirs.

- The 1970s: **geophysic**: seismic
- The 1980s: 3D seismic: seismic section of the earth crust in any direction.

- Imagine the geometry of the reservoir
- To detect the presence of oil and gas.

Geochemistry:

- To match petroleum to the source rock,
- Identify their tendency to generate oil or gas
- Identify their thermal level to maturation